STUDY 53

CARBONATITE - ALKALIC ROCK COMPLEXES: CARB LAKE

OGS

Mines and Minerals Division

Ontario Geological Survey
Study 53

Geology of

Carbonatite – Alkalic Rock Complexes in Ontario:

"Carb" Lake Carbonatite Complex

District of Kenora

1987

Ontario

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Mines and Minerals Division

Ontario Geological Survey
Study 53

Geology of Carbonatite – Alkalic Rock Complexes in Ontario

"Carb" Lake Carbonatite Complex

District of Kenora

by R.P. Sage

1987

Ministry of
Northern Development
and Mines
Ontario

Foreword

The Carb Lake Carbonatite Complex was examined as part of a project, begun in 1974, to study alkalic rock - carbonatite complexes in Ontario. The report describes the rock types and mineralogy of the Carb Lake Carbonatite Complex and outlines the history of the mineral exploration efforts within the complex.

V.G. Milne
Director
Ontario Geological Survey

Contents

Abstract 2
Introduction 3
Acknowledgments 3
Location and Access 3
Field Methods 3
Previous Geological Work 3
Physiography 3
Laboratory Techniques 3
Nomenclature 5
General Geology 5
Archean 6
Granitic Gneiss 6
Proterozoic 6
Sovite and Silicocarbonatite (Minor Biotitite and Magnetitite) 6
Petrology 6
Metamorphism 11
Structural Geology 11
Regional Setting 12
Local Structure 12
Recommendations for Future Study 12
Economic Geology 12
Property Descriptions 13
Big Nama Creek Mines Limited [1968] 13
International Minerals and Chemical Corporation [1975] 13
Recommendations to the Prospector 13
Appendix A — Petrographic Descriptions and Chemical Analyses of Samples 13
References 14
Index 38

TABLES

1. Table of lithologic units 9
2. X-Ray diffraction determinations of minerals from vugs in drill core 10
A-1. Petrographic descriptions of samples 14
A-2. Major element chemical analyses of samples 21
A-3. Trace element chemical analyses of samples 24
A-4. Normative (LeBas) compositions of samples 30
A-5. Average chemical compositions of lithologic units 36

FIGURES

1. Key map showing location of the "Carb" Lake Complex 4
2. Aeromagnetic map of the "Carb" Lake Complex 7
3. Geology of the "Carb" Lake Complex 8

CONVERSION FACTORS FOR MEASUREMENTS IN ONTARIO GEOLOGICAL SURVEY PUBLICATIONS.

CONVERSION FROM SI TO IMPERIAL			CONVERSION FROM IMPERIAL TO SI		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
		LENGTH			
1 mm	0.039 37	inches	1 inch	**25.4**	mm
1 cm	0.393 70	inches	1 inch	**2.54**	cm
1 m	3.280 84	feet	1 foot	**0.304 8**	m
1 m	0.049 709 7	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
		AREA			
1 cm^2	0.155 0	square inches	1 square inch	**6.451 6**	cm^2
1 m^2	10.763 9	square feet	1 square foot	**0.092 903 04**	m^2
1 km^2	0.386 10	square miles	1 square mile	2.589 988	km^2
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
		VOLUME			
1 cm^3	0.061 02	cubic inches	1 cubic inch	**16.387 064**	cm^3
1 m^3	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m^3
1 m^3	1.308 0	cubic yards	1 cubic yard	0.764 555	m^3
		CAPACITY			
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	**4.546 090**	L
		MASS			
1 g	0.035 273 96	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 75	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2.204 62	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	**907.184 74**	kg
1 t	1.102 311	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	**1.016 046 908 8**	t
		CONCENTRATION			
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

1 ounce (troy) per ton (short)	20.0	pennyweights per ton (short)
1 pennyweight per ton (short)	0.05	ounces (troy) per ton (short)

Note. Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries, published by the Mining Association of Canada in cooperation with the Coal Association of Canada.

GEOLOGY OF CARBONATITE – ALKALIC ROCK COMPLEXES IN ONTARIO

"Carb" Lake Carbonatite Complex

DISTRICT OF KENORA

R.P. Sage[1]

1. Geologist, Precambrian Geology Section, Ontario Geological Survey, Toronto.

Manuscript approved for publication, January 27, 1983, by John Wood, Chief Geologist, Ontario Geological Survey. This report is published with the permission of V.G. Milne, Director, Ontario Geological Survey.

Abstract

The "Carb" Lake Carbonatite Complex occurs in the Kenyon Structural Zone of the Superior Province of the Canadian Shield. The carbonatite complex was likely emplaced along northwest-trending fault structures, however geological and geophysical data to support this interpretation are lacking. The complex has been dated by K-Ar isotope methods at 1826 ± 97 Ma.

The complex consists of sovite and silicocarbonatite with minor narrow bands rich in magnetite. Vugs are common in drill core, and the surface of the complex may have been leached.

Exploration of the complex has been very limited, but it has disclosed high concentrations of rare earths and some anomalous niobium values. A radioactive dispersion halo extends southwest from the complex. The intrusion is relatively untested and should be examined for both residual and primary mineral accumulations typical of carbonatite intrusions.

RESUME

Le complexe de carbonatite du lac "Carb" apparaît dans la zone structurale de Kenyon de la province Supérieure du Bouclier canadien. Le complexe de carbonatite se situait probablement le long de failles qui tendent vers le nord-ouest. On manque cependant de données géologiques et géophysiques pour étayer cette interprétation. Le complexe a pu être daté au moyen de méthodes isotopiques K-Ar à 1826 ± 97 Ma.

Le complexe est formé de sovite et de silicocarbonatite contenant d'étroites bandes mineures intercalées de roches secondaires riches en magnétite. On trouve de nombreuses géodes dans les carottes de sondage et il se peut que la surface du complexe ait été lixiviée.

L'exploration du complexe a été très limitée, mais elle a révélé de fortes concentrations de terres rares et certaines quantités anormales de niobium. Un halo de dispersion radioactif s'étend du complexe en direction sud-ouest. L'intrusion a été relativement peu explorée et il faudra y rechercher les accumulations minérales primaires et résiduelles typiques d'intrusions de carbonatite.

Geology of Carbonatite – Alkalic Rock Complexes in Ontario: "Carb" Lake Carbonatite Complex, District of Kenora, by R.P. Sage. Ontario Geological Survey, Study 53, 42p. Published 1987. ISBN 0-7729-0588-6.

Introduction

The "Carb" Lake[1] Carbonatite Complex is the most northerly carbonatite in Ontario that has been tested for its mineral content and confirmed to be a carbonatite intrusion. Some other aeromagnetic anomalies lying north of Carb Lake, caused by rocks beneath the sedimentary rocks of the Hudson Bay Lowlands, could be interpreted as carbonatite intrusions (ODM-GSC 1970a,b; Satterly 1970).

As part of a program to examine alkalic rock - carbonatite complexes in Ontario, diamond drill core from the drill site at Carb Lake was recovered for examination, and samples that had been collected during Operation Lingman Lake (Bennett and Riley 1969) were re-examined. The complex is known to contain niobium and rare earths (Bennett and Riley 1969). A radiometric anomaly is coincident with the aeromagnetic anomaly but is slightly displaced to the southwest in the direction of glacial transport (Ferguson 1971). Testing of the complex has indicated that it contains sovite and silicocarbonatite and local magnetite-rich accumulations. The complex warrants exploration for niobium, rare earths, uranium and apatite.

ACKNOWLEDGMENTS

The author was assisted by Mr. W. Wright, senior geological assistant, in recovering drill core remaining in the bush. Aircraft for the project were chartered from Severn Enterprises Limited, Pickle Lake.

LOCATION AND ACCESS

The Carb Lake Carbonatite Complex is the most northerly carbonatite complex in Ontario (Figure 1). The intrusion is located at approximately 54°46'N Latitude and 92°01'W Longitude, 10 km east of the Ontario-Manitoba boundary. The complex lies 384 km west-northwest of Pickle Lake and 422 km north-northeast of Red Lake. The complex is accessible only by float-equipped aircraft to either "Camp" Lake (local name) on the northern edge of the complex or to Carb Lake located at the northwest corner of the complex.

FIELD METHODS

The complex is not exposed at surface and thus field mapping is impossible. Airphotos of the area were obtained from the National Airphoto Library, Ottawa. Surface features of the complex were interpreted from the airphotos. Exploration data and drill hole data were obtained from the Assessment Files Research Office, Ontario Geological Survey.

PREVIOUS GEOLOGICAL WORK

The only published description of the geology of the complex is that of Bennett and Riley (1969). Ferguson (1971) gave a brief synopsis of the complex.

PHYSIOGRAPHY

The topography is low, undulating and mostly swampy. The complex does not outcrop. Eskers are present east of the complex and their southwest to south trend can be easily seen on airphotos of the area.

The intrusion has a surface area of approximately 8.0 km^2, estimated on the basis of a strong circular aeromagnetic anomaly (see Figure 2) which is well illustrated on aeromagnetic maps 3684G, 3692G, 3685G and 3693G (ODM-GSC 1967).

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[1] "Carb" Lake is not an official geographic name.

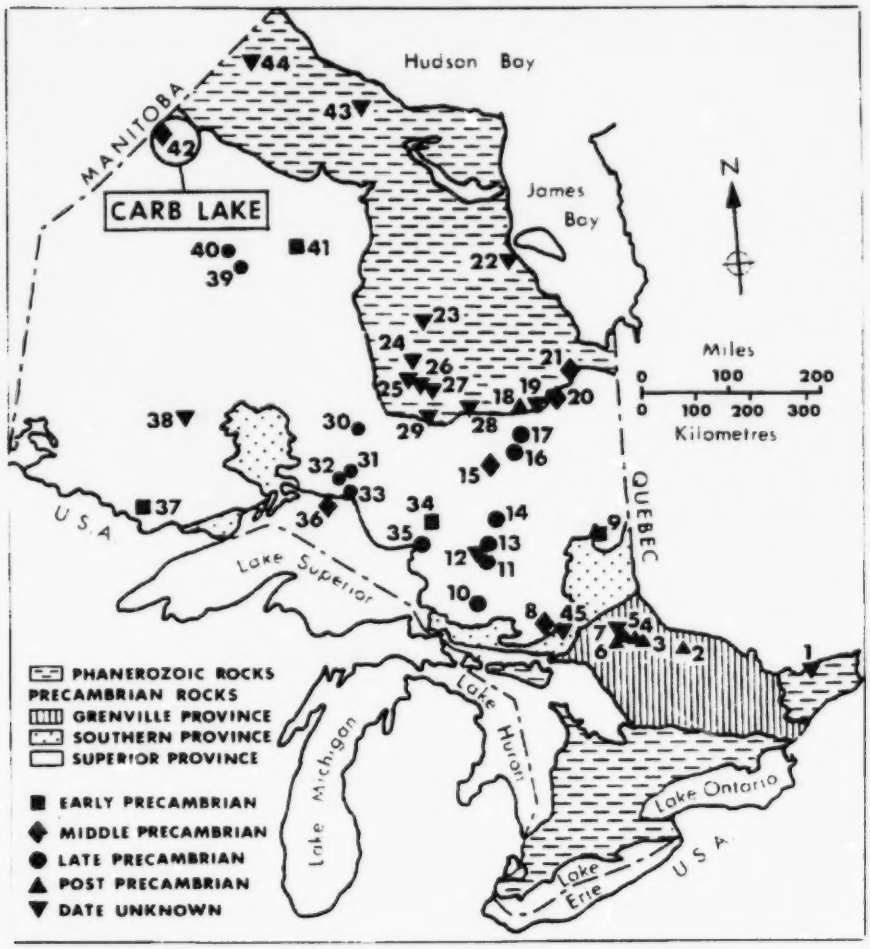

Figure 1. *Key map showing location of carbonatite – alkalic rock complexes in Ontario.*

1. *Eastview*
2. *Brent*
3. *Callander B.*
4. *Manitou Is.*
5. *Burritt Is.*
6. *Iron Is.*
7. *Lavergne*
8. *Spanish R.*
9. *Otto Stock*
10. *Seabrook L.*
11. *Lackner L.*
12. *Borden L.*
13. *Nemegosenda L.*
14. *Shenango Tp.*
15. *Cargill Tp.*
16. *Teetzel Tp.*
17. *Clay-Howells*
18. *Hecla-Kilmer*
19. *Valentine Tp.*
20. *Goldray*
21. *Argor*
22. *Lawashi R.*
23. *Poplar R.*
24. *Albany Forks*
25. *L. Drowning R.*
26. *Kingfisher R. W.*
27. *Kingfisher R. E.,*
28. *Martison L.*
29. *Nagagami R.*
30. *Chipman L. (dikes)*
31. *Killala L.*
32. *Prairie L.*
33. *Port Coldwell*
34. *Herman L.*
35. *Firesand R.*
36. *Slate Is.*
37. *Poohbah L.*
38. *Sturgeon Narrows & Squaw L.*
39. *Schryburt L.*
40. *Big Beaver House*
41. *Wapikopa L.*
42. ***"Carb" L.***
43. *Gooseberry Br.*
44. *Niskibi L.*
45. *Nemag L. & Lusk L.*

LABORATORY TECHNIQUES

Thin sections were prepared from core samples. A selected group of samples representing homogeneous, equigranular phases of the body were analyzed for major and minor elements (see Appendix A). Samples containing vugs were neither thin sectioned nor analyzed. The surface layer was removed from all samples, prior to analysis, by a grinding wheel to remove the effects of weathering of the core which had lain in the bush for approximately 10 years. Minerals lining cavities within the core were analyzed by X-ray diffraction. All thin sections and samples described in this report are stored at the Royal Ontario Museum, Toronto.

NOMENCLATURE

The various lithologic units of alkalic rock - carbonatite complexes within Ontario were originally defined by Parsons (1961). The author has used a somewhat different nomenclature than Parsons. For the alkalic rocks, the author prefers to use mineralogical, colour, or textural modifiers which are familiar to all readers rather than unfamiliar rock names. Alkalic rock nomenclature is cumbersome, due in large part to the profusion of rock names; consequently, as an aid to the reader, the use of less familiar rock names will be avoided.

Sovite. A carbonatite rock composed of 50 percent or more calcite. Various mineralogic modifiers are used to classify the sovite.

Silicocarbonatite. A carbonate-rich igneous rock composed of 50 percent or more silicate and oxide minerals. Where the silicate mineralogy exceeds 90 percent, various other rock names are applied, i.e., ijolite, biotite pyroxenite, etc.

The definitions of sovite and silicocarbonatite are modified from Heinrich (1966, p.12). The author has found Heinrich's classification of the carbonate-rich rocks generally suitable for field use upon modification to a two-fold subdivision at about 50 percent oxide and silicate mineral content. The two-fold subdivision is more convenient than the four-fold subdivision of Heinrich (1966) because carbonatites are extremely variable in mineral content over distances as small as a few centimetres. It is difficult to rigorously classify such rocks.

General Geology

The Carb Lake Carbonatite Complex (Figures 2 and 3) lies within the Kenyon Structural Zone of the Superior Province (Ayres *et al.* 1971). This structural zone is characterized geophysically by a strong linear, west-northwest trending aeromagnetic pattern (ODM-GSC 1970). Mapping by Bennett and Riley (1969) and Riley and Davies (1967a,b) indicated that Archean felsic intrusive rocks outcrop east of the Carb Lake Carbonatite Complex.

The core from drill holes No. 3 and 4 of Big Nama Creek Mines Limited and Larandona Mines Limited were examined by the author. They are composed dominantly of pink to grey-white sovite containing minor amounts of biotite, magnetite and biotite-phlogopite. The core contains minor zones (up to 1-2 m) of silicocarbonatite and biotitite (more than 90 percent biotite with minor magnetite). Thin zones, less than 0.3 m wide, of nearly pure magnetite are locally present. The carbonatite is well banded at 30-45 degrees to the core axis, and all rock types (sovite, silicocarbonatite, biotitite, and magnetitite) are so intimately mixed that pure samples more than 15 cm long, of any one type, are difficult to obtain. The silicocarbonatite and biotitite commonly contain numerous, nearly pure, carbonate segregations or veins which impart a brecciated appearance to the core. Several thin (less than 2 mm wide) seams of fibrous blue-green amphibole were noted.

The core is unusual in that it is very vuggy. The vugs are roughly elongated parallel to the banding, in places exceeding 1 cm in length, and are lined with pyrite, fluorite, and euhedral carbonate crystals. Some of the vugs appear to follow fractures and may have been formed near surface by solution-deposition, i.e. they may be secondary phenomena rather than miarolitic cavities. Vugs were noted in the core to the greatest depths penetrated by drilling.

K. Bell and D. Watkinson of Carleton University (1972, unpublished data) reported K-Ar isotopic ages of 1822 $\pm$ 96 Ma and 1826 $\pm$ 97 Ma on biotite samples taken from diamond drill core.

Table 1 lists the lithologic units found at the Carb Lake Carbonatite Complex.

ARCHEAN

GRANITIC GNEISS

Mapping by Riley and Davies (1967b) has indicated that the outcrops closest to the Carb Lake Carbonatite Complex lie along the Echoing River 3.2 km southeast of the complex and along the shore of an unnamed lake 6.4 km northeast of the complex. These outcrops consist of hybrid granite and granitic gneiss (Riley and Davies 1967b). The author made no attempt to visit these outcrops.

PROTEROZOIC

The Carb Lake Carbonatite Complex is one of several middle Proterozoic carbonatite intrusions in Ontario. Other middle Proterozoic complexes are the Spanish River, Argor, Goldray, and Cargill Township complexes (Sage 1983a,b,c,d).

In thin section, rocks classified as sovite and silicocarbonatite are gradational into each other and contain identical minerals and petrographic features. Consequently, the two rock units are described together.

SOVITE AND SILICOCARBONATITE (MINOR BIOTITITE AND MAGNETITITE)

The core is banded and commonly contains well developed vugs lined with euhedral crystals. The crystals within the vugs were examined by X-ray diffraction (Table 2) by W. Hicks, Geoscience Laboratories, Ontario Geological Survey.

Fluorite in pale purple cubic crystals, up to 2 mm on an edge, were noted in several vugs but their presence was not confirmed by X-ray diffraction.

Neither X-ray diffraction nor petrographic examination confirmed the presence of the rare earth - bearing carbonates synchysite $(Ce,La,Ca)FCO_3$ and ancylite $(Ce,La)_4(Sr,Ca)_3(CO_3)_7(OH)_4.3H_2O$ previously identified by X-ray diffraction and reported by Bennett and Riley (1969).

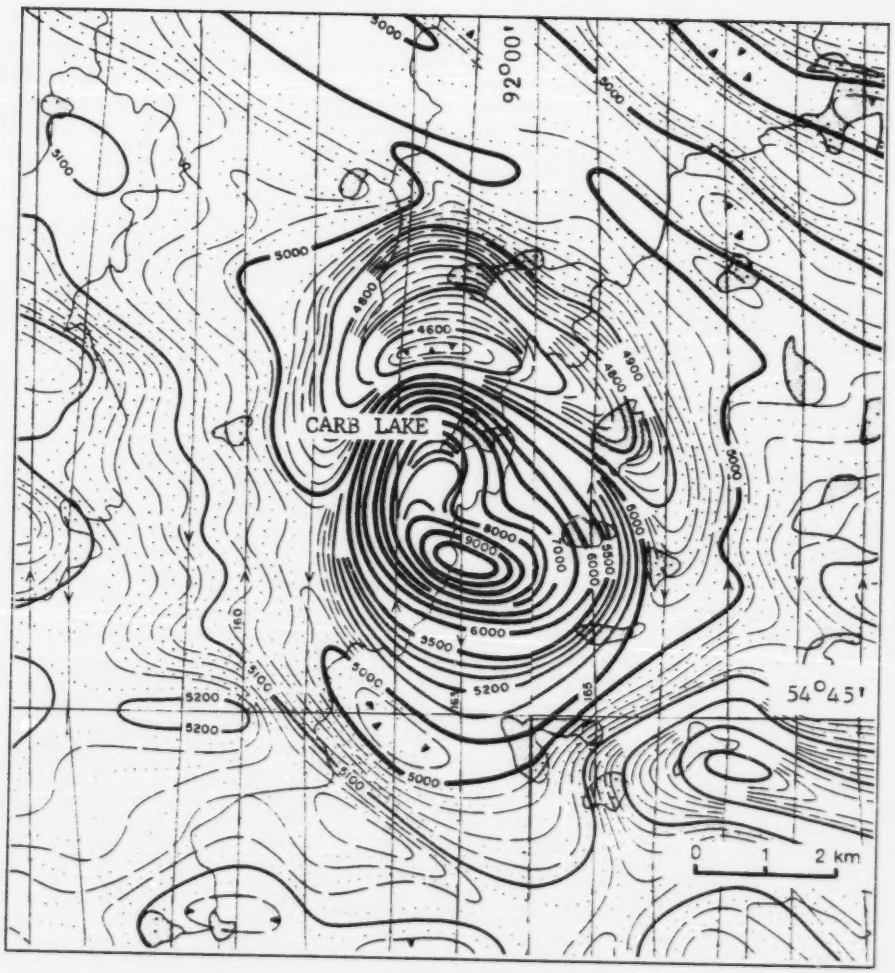

Figure 2. *Aeromagnetic map of the Carb Lake Carbonatite Complex (ODM-GSC 1967).*

LEGEND

CENOZOIC

QUATERNARY

PLEISTOCENE AND RECENT

Sand, gravel, boulders; lake and stream deposits.

Unconformity

PROTEROZOIC

"CARB" LAKE CARBONATITE COMPLEX

D2 Sovite, silicocarbonatite, biotitite, magnetitite (drill hole data).

Intrusive contact

ARCHEAN

GRANITIC GNEISS

G1 Granitic gneiss (interpreted from geophysical data).

ap ..... Apatite
mag ..... Magnetite
pyl ..... Pyrochlore

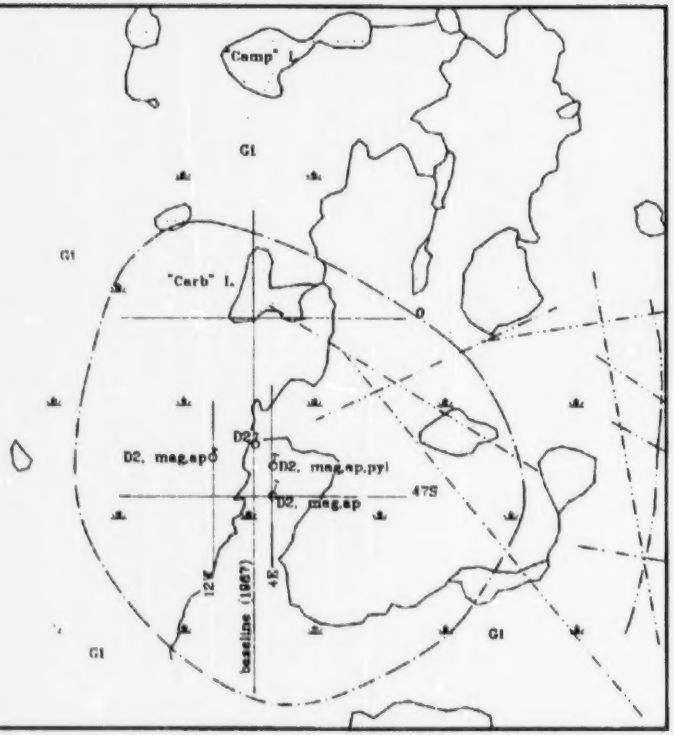

Figure 3. *Geology of the "Carb" Lake Carbonatite Complex. Geology interpreted by R.P. Sage from geophysics and diamond drill core.*

TABLE 1. TABLE OF LITHOLOGIC UNITS FOR THE "CARB" LAKE CARBONATITE COMPLEX

CENOZOIC
QUATERNARY
PLEISTOCENE AND RECENT
Stream, swamp and glacial deposits
Unconformity

PROTEROZOIC
"CARB" LAKE CARBONATITE COMPLEX
Sovite, silicocarbonate, biotitite, and magnetitite
Intrusive Contact

ARCHEAN
Granitic gneiss

The spectrographic analyses reported by Bennett and Riley (1969) showed very high concentrations of rare earth elements in some samples.

Bennett and Riley (1969) described the rare earth carbonates as follows:

"Synchysite ... forms irregular soft pinkish patches or veinlets in carbonatite. It is associated with fluorite and is probably of late hydrothermal origin. In thin section synchysite forms pale-brown scaly masses.

"Ancylite ... is another rare earth-bearing mineral of which only a few occurrences are known. It was identified in a sample taken from a boulder on the shore of a small lake overlying the carbonatite. Ancylite forms deep red clots about 1/2 inch across a carbonatite: in thin section it is orange in colour but is too fine-grained for optical properties to be determined. Spectrographic analysis indicated a cerium content of 2 percent and a lanthanum content of 1 percent for part of the rock specimen."

The vugs appear to be elongated parallel to the banding in the core and thus are mineralogically and/or structurally controlled. The mineralogy of the vugs is not diagnostic as to whether the vugs are primary or the result of leaching by surface waters. With the exception of magnetite, phlogopite, pyrrhotite, and amphibole, the minerals found are not uncommon in limestone formations which have been subjected to circulating ground waters. Close examination of the vugs suggests that the four minerals listed above were left projecting into cavities after the enclosing carbonate was leached away by circulating ground waters. This interpretation places severe restrictions on sampling of the core for thin section and chemical analysis if one hopes to obtain pristine rock textures and chemical data.

In thin section the sovite and silicocarbonatite are fine to medium grained, massive, hypidiomorphic to allotriomorphic with straight to curved grain boundaries. The mode is estimated to be 0 to 30 percent amphibole, 0 to 75 percent biotite-phlogopite, trace to 60 percent magnetite, 0 to 30 percent apatite, and 10 to 100 percent carbonate. Pyrochlore, garnet, fluorite, chlorite, albite, pyrrhotite, nepheline and zircon are present in one or more thin sections. Locally, the composition varies to biotitite and magnetitite.

The amphibole occurs as euhedral, acicular crystals. The crystals have a pale green pleochroism and some of the larger grains have a nonpleochroic core implying compositional zonation. The crystals may be richterite, a sodium-bearing amphibole. In places, the amphibole occurs as clots made up of very fine-grained needle-like crystals. Twin planes are evident in some sections normal to the long axis of the crystal.

The mica is classified as biotite-phlogopite with biotite being dominant. The crystals vary from euhedral tabular grains to irregular ragged grains. The smaller grains are pleochroic in red-brown and were optically identified as biotite. Uncommon in the small grains and very common in the larger grains is the development

TABLE 2. X-RAY DIFFRACTION DETERMINATIONS OF MINERALS FROM VUGS IN DRILL CORE SAMPLES FROM THE "CARB" LAKE CARBONATITE COMPLEX.

Sample	X-ray Diffraction Determination
Light brown to brown carbonate	Dolomite, most likely ferruginous due to red-brown weathering of surface.
White-weathering carbonate	Calcite.
Fibrous blue green to greenish blue material	All X-ray patterns indicate an amphibole structure.
Small white glassy crystals	Quartz.
Dark metallic minerals	All X-ray patterns indicate magnetite.
Coppery coloured sulphides	X-ray diffraction patterns for pyrite, marcasite, and pyrrhotite were obtained.
Light brown micaeous mineral	Phlogopite.
Very fine-grained earthy red mineral	Hematite

Note: Determinations by W. Hicks, Geoscience Laboratories, Ontario Geological Survey.

of a pale yellow-brown core and dark red-brown rim. These grains are interpreted to have phlogopite cores and biotite rims. This pronounced zoning has been observed by the author in other middle Proterozoic carbonatites of Ontario; for example, the Cargill Township and Spanish River complexes (Sage 1983a,d). Indented, ragged edges, which sometimes have a worm-eaten appearance, are commonly found on the larger grains and suggest that the compositional zonation of mica may be in part due to reaction with the carbonatite melt.

The mica is penetrated by amphibole crystals, and in one thin section small, poikilitically enclosed grains (probably zircon) with dark radioactive bombardment haloes were noted. One thin section displays fine-grained dusty magnetite within some of the biotite crystals and biotite uncommonly occurs as fine-grained aggregates. Bending of the (001) cleavage is present in some thin sections but kinking is very rare. This observation suggests that the Carb Lake Carbonatite Complex is relatively undeformed compared to the Cargill Township and Spanish River complexes where deformation of the mica is locally extensive (Sage 1983a,d).

Biotite has been noted to occur along the margins of, and interlock with, some magnetite grains, and in several instances it appears to poikilitically enclose rounded polycrystalline blebs of carbonate. Rarely does the biotite enclose an apatite grain.

Magnetite is common as disseminated, anhedral to sharply euhedral grains. A few larger grains of magnetite contain rounded polycrystalline blebs of carbonate. Small red-brown grains of biotite may also be present within these carbonate blebs.

Apatite forms anhedral to subhedral grains, round to rounded-elongate in shape. The apatite uncommonly occurs as round to subangular polycrystalline aggregates. The apatite generally is scattered throughout the thin sections.

Carbonate forms an interlocking mosaic of anhedral grains. The grains have curved to lobate boundaries. Yellow-brown and white weathered areas within the

core indicate that there are two carbonate phases, but the two phases cannot generally be distinguished in thin section. Where two carbonates are apparent, one is turbid in appearance because of dust-like inclusions and the other is clear. The turbid carbonate is likely ferruginous dolomite and the clear carbonate may be calcite. From the appearance of the weathered core, dolomite and calcite are rather intimately mixed. It is estimated that the weathered core has at least local concentrations of 30 to 40 percent ferruginous dolomite.

In one thin section several carbonate grains contain nepheline (?) cores with which the carbonatite magma likely reacted.

Garnet with a dark brown core and a narrow pale brown rim is present in one thin section. The garnet is anhedral to subhedral in form and likely reacted with the carbonatite magma to form the narrow pale brown rim.

Fluorite is present in several thin sections. The mineral is anhedral and appears interstitial to intergranular with the carbonate. The fluorite appears to be late within the paragenetic sequence and may partially enclose some carbonate grains.

Traces of anhedral pyrrhotite are present in some thin sections.

Pyrochlore is not common but does occur in a number of thin sections. The mineral is euhedral, strongly zoned with alternating concentric dark brown to very pale-brown zones. The mineral occurs as isolated grains in the carbonate and more rarely along the margins of magnetite grains. The pyrochlore content of the rock rarely approaches or exceeds 1 percent.

PETROLOGY

A very limited group of core samples (Appendix A, Table A-1) from the Carb Lake intrusion were selected for complete rock analysis (Appendix A, Tables A-2 and A-3). The core samples are the most homogeneous sections of the core available, and vuggy core was not analyzed. The samples are essentially from only two of four holes drilled and cannot be considered representative of the complex. The reader should note the unusually high content of rare earth elements in several of the samples.

Carbonatites are likely the product of liquid immiscibility and therefore the chemical compositions of the rocks cannot be used for postulating chemical trends within carbonatite melts (Nash 1972; Hamilton *et al.* 1979; LeBas and Handley 1979; Freestone and Hamilton 1980). The carbonatite is considered to be a residuum, with some of the alkalies in the original melt lost to the wall rocks during the process of fenitization.

Alkalic rock norms (Appendix A, Table A-4) were calculated by the techniques of LeBas (1973). The limited chemical data have been statistically analyzed (Appendix A, Table A-5) using the methods of Nie *et al.* (1975). The statistical analyses are for comparative purposes only.

METAMORPHISM

The Carb Lake intrusion lacks textural evidence of metamorphism. The reaction rims on the biotite-phlogopite are interpreted by the author to have resulted from late-stage magmatic processes and thus are not the result of an independent metamorphic event.

The lack of deformation textures within the micas at the Carb Lake Carbonatite Complex implies that deformation-recrystallization has been negligible; this is in contrast with deformation textures found in the Cargill Township and Spanish River complexes of similar age (Sage 1983a,d).

STRUCTURAL GEOLOGY

REGIONAL SETTING

The Carb Lake Carbonatite Complex is located in the Kenyon Structural Zone of the Superior Province of the Canadian Shield (Ayres *et al.* 1971).

The lack of outcrop near the complex makes structural interpretation difficult. A linear pattern in isomagnetic contours on the regional aeromagnetic map (Map P.575, ODM-GSC 1970) of the area suggests that the intrusion may be located along a northwest-trending structure whose characteristics are unknown.

LOCAL STRUCTURE

Mineralogic banding in the core (from a hole drilled at a 50 degree plunge) varies from 30 to 50 degrees to the core axis, and indicates that the banding in the intrusion is probably vertical or nearly vertical. The banding is a function of rapidly varying ratios of the various mineral components.

Vugs up to 1 cm in diameter within the carbonatite tend to be elongated parallel to the banding. Leaching of the carbonatite to form these vugs (see "General Geology") was thus controlled by the mineralogical banding.

RECOMMENDATIONS FOR FUTURE STUDY

Microprobe analysis of the various mineral components is desirable, and additional optical work with a universal stage is also recommended. The age of the complex warrants checking by another isotopic technique to confirm the middle Proterozoic age. More detailed studies must await additional exploration work to provide additional sample material.

Economic Geology

The complex is known to contain niobium and rare earth elements (Bennett and Riley 1969). A fan-shaped radioactive dispersion halo extends south from the complex parallel to the direction of ice movement (Ferguson 1971). Leaching of the carbonatite suggests that residual deposits containing apatite, pyrochlore, vermiculite and rare earth elements may be present.

PROPERTY DESCRIPTIONS

BIG NAMA CREEK MINES LIMITED [1968]

In 1968, Big Nama Creek Mines Limited and Larandona Mines Limited staked the Carb Lake Carbonatite Complex, completed a magnetometer survey, and drilled four diamond drill holes totalling 1,849 feet (Assessment Files Research Office, Ontario Geological Survey, Toronto). The company also completed airborne magnetic and radiometric surveys (D.A. Seeber, Northgate Exploration Limited, personal communication 1971).

INTERNATIONAL MINERALS AND CHEMICAL CORPORATION [1975]

In 1975 the International Minerals and Chemical Corporation staked the complex as a prospect for residual apatite. The company completed no work on the body and the claims were allowed to lapse.

RECOMMENDATIONS TO THE PROSPECTOR

Testing for niobium, by Big Nama Creek Mines Limited and Larandona Mines Limited, was confined to magnetic anomalies and thus the niobium potential of the intrusion remains open. The complex is known to be radioactive and also contains rare earth elements; neither commodity has yet been investigated for its economic potential.

Drilling by Big Nama Creek Mines Limited encountered bedrock at 6.6 to 12.0 m, however, the vuggy nature of the core suggests extensive leaching. Prospecting to locate depressions or solution cavities where residual accumulations of minerals may occur within the complex is warranted. Such cavities may contain accumulations of apatite, vermiculite, pyrochlore (niobium) and rare earth elements.

Economic evaluation of the complex is difficult because of the limited information collected to date. However, for those interested in carbonatite-type mineralization, the Carb Lake Carbonatite Complex would appear to offer a good and largely untested exploration target.

Appendix A

Petrographic Descriptions, Chemical Analyses, Normative Compositions, and Statistical Compositions of Lithologic Units of the "Carb" Lake Carbonatite Complex.

TABLE A–1. PETROGRAPHIC DESCRIPTIONS OF WHOLE–ROCK SAMPLES FROM THE "CARB" LAKE CARBONATITE COMPLEX.

Map No. 1154
Sample No. 3-53-82B
Pyrochlore-bearing, biotite - amphibole - magnetite sovite.

Fine to medium grained, massive, equigranular, hypidiomorphic. Pyrochlore forms euhedral crystals which are brown in colour, and have strong concentric zoning. It occurs as isolated grains in carbonate and along margins of magnetite grains. Amphibole forms acicular crystals. Magnetite forms anhedral to euhedral grains disseminated throughout. Magnetite locally encloses rounded blebs of carbonate. Biotite forms tabular reddish-brown grains isolated in carbonate and along margins of some magnetite grains. Carbonate grains form an interlocking mosaic. The sample is cut by a fracture containing a mixture of carbonate and amphibole. The chemically analyzed sample is homogeneous, equigranular and magnetite-rich.

Map No. 1155
Sample No. 3-53-82A
Biotite sovite.

Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Traces of pyrochlore occur as euhedral crystals, which are strongly concentrically zoned. Biotite forms aggregates of small grains between larger carbonate grains. Biotite content is minor. Carbonate forms an interlocking mosaic of anhedral grains with curved grain boundaries.

Map No. 1157
Sample No. 3-82-107A
Biotite - amphibole - magnetite sovite.

Fine grained, massive, inequigranular-seriate, hypidiomorphic. Biotite locally partially encloses amphibole and one fractured grain is traversed by a fine grained aggregate of amphibole. Larger grains have a bent (001) cleavage. Larger biotite grains are ragged with pale brown phlogopite cores and dark reddish-brown rims. Amphibole occurs as euhedral acicular crystals and as very fine-grained fibrous aggregates. Magnetite forms subhedral to euhedral crystals. Some larger grains contain rounded polycrystalline blebs of carbonate. These inclusions may also contain small grains of reddish-brown biotite.

Map No. 1158
Sample No. 3-107-135B
Apatite - biotite - amphibole - magnetite sovite.

Fine grained, massive, equigranular, hypidiomorphic. Rare pyrochlore occurs as euhedral grains. One large crystal occurs in magnetite. Magnetite forms anhedral to euhedral grains. Biotite forms ragged, generally small reddish-brown grains partially enclosing amphibole and occurring along margins of magnetite. Larger grains have brown cores and reddish brown rims. Amphibole forms acicular fibrous aggregates and long needle-like crystals. Apatite forms interlocking aggregates of anhedral grains. Carbonate grains are anhedral and form an interlocking mosaic.

Map No. 1159
Sample No. 3-107-135C
Biotite - apatite sovite.

Fine grained, massive, equigranular, allotriomorphic with curved grain boundaries. Apatite forms anhedral to subhedral rounded and sometimes elongate grains. Apatite is crudely clustered into aggregates of grains in some areas. Biotite forms

fine-grained aggregates and isolated grains between carbonate grains. Carbonate forms an interlocking mosaic of anhedral grains with curved grain boundaries.

Map No. 1160
Sample No. 3-186-210B
Apatite - magnetite - biotite sovite.

Fine grained, massive, equigranular, hypidiomorphic. Apatite forms anhedral to subhedral rounded to rounded-elongate grains. Magnetite forms anhedral to euhedral crystals disseminated throughout and weakly concentrated into bands; some larger grains enclose carbonate grains which occasionally may also include a grain of biotite. Biotite forms anhedral to subhedral grains disseminated throughout. Cores of grains are brown while rims are reddish-brown. Some grains interdigitate with and partially enclose carbonate. Anhedral grains of carbonate form an interlocking mosaic.

Map No. 1161
Sample No. 3-186-210C
Amphibole - apatite - biotite sovite.

Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Apatite forms anhedral to subhedral grains, rounded to rounded-elongate in shape. Biotite forms anhedral to subhedral, ragged to tabular grains. Larger grains have brown cores and dark reddish-brown rims. Edges of some grains appear worm eaten. Amphibole is present as pale green acicular needles, sometimes occurring as clusters of crystals. Crystals are euhedral. Carbonate forms an interlocking mosaic of anhedral grains.

Map No. 1162
Sample No. 3-234-259A
Biotite - apatite sovite.

Fine grained, equigranular, allotriomorphic, with curved to straight grain boundaries. Apatite forms anhedral to euhedral grains which are rounded and sometimes elongate in outline. Biotite forms anhedral grains with ragged grain boundaries which appear worm-eaten. Cores of crystals are a much lighter brown than the dark reddish-brown rims. Carbonate forms an interlocking mosaic of anhedral grains.

Map No. 1163
Sample No. 3-234-259B
Apatite - magnetite - amphibole - biotite sovite.

Fine grained, massive, equigranular, hypidiomorphic. Apatite forms rounded to subangular anhedral grains, often elongate in outline. Magnetite forms anhedral to subhedral grains disseminated throughout. Amphibole forms euhedral, acicular crystals, pleochroic in pale green. Some of the smaller crystals occur in fibrous clusters. Biotite forms tabular to irregular, anhedral, reddish-brown grains.

Map No. 1164
Sample No. 3-285-312C
Apatite-bearing, biotite - amphibole sovite.

Fine grained, massive, equigranular, hypidiomorphic. Minor apatite forms rounded to rounded-elongate grains, anhedral to subhedral in form. Amphibole forms acicular, euhedral, pleochroic (pale green) crystals; local areas consist of very fine-grained fibrous aggregates of crystals. Biotite is tabular, anhedral to subhedral, and brown; it occurs intergranular to carbonate. Anhedral carbonate with curved grain boundaries forms an interlocking mosaic.

Map No. 1165
Sample No. 3-312-337D
Biotite - magnetite sovite.

Fine grained, massive, equigranular, hypidiomorphic. Magnetite is anhedral to subhedral in form, and locally encloses rounded blebs of carbonate. Biotite forms anhedral, tabular to ragged grains with a dark reddish-brown colour. Traces of amphibole and apatite are present.

Map No. 1166
Sample No. 3-363-395A
Amphibole - magnetite - biotite silicocarbonatite.

Fine grained, massive, equigranular, hypidiomorphic. Amphibole forms long needle-like crystals with a pale green pleochroism. Magnetite forms anhedral to euhedral grains and is disseminated throughout. It locally encloses blebs of carbonate and traces of biotite. Biotite forms anhedral ragged grains interlocking with and penetrated by amphibole crystals. Carbonate forms anhedral grains in an interlocking mosaic.

Map No. 1167
Sample No. 3-414-439B
Biotite - amphibole - magnetite sovite.

Fine grained, massive, equigranular, hypidiomorphic. Magnetite forms anhedral to euhedral grains, and locally encloses blebs of carbonate. Traces of euhedral pale brown pyrochlore occur in carbonate and as small grains on margins of magnetite grains. Amphibole forms euhedral needle-like crystals with a pale green pleochroism. Biotite forms anhedral, irregular crystals, commonly interlocking with magnetite and partially enclosed in magnetite. Larger grains have pale brown cores and dark reddish-brown rims. Edges of larger grains are commonly ragged. Anhedral carbonate forms an interlocking mosaic with other minerals.

Map No. 1168
Sample No. 3-439-454B
Amphibole - magnetite - biotite silicocarbonatite.

Fine grained, massive, equigranular, hypidiomorphic. Amphibole forms long, acicular, euhedral crystals. Magnetite forms euhedral to anhedral, disseminated grains. Biotite forms anhedral to subhedral grains; some grains contain small poikilitic magnetite inclusions. Colour variation in pleochroism suggests that the crystals are zoned from a brown core to a reddish-brown rim. Carbonate forms an interlocking mosaic of anhedral grains.

Map No. 1169
Sample No. 4-39-64A
Biotite - amphibole - apatite - magnetite sovite.

Fine to medium grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Apatite forms subhedral, rounded, sometimes elongate grains. Grains are isolated or occur as aggregates of many grains. Magnetite is anhedral to subhedral, disseminated, and locally contains rounded blebs of carbonate. Amphibole forms small fibrous aggregates and clusters of grains. Biotite-phlogopite consists of anhedral, often ragged grains with light pale brown cores (phlogopite) and dark reddish-brown rims. Some large grains enclose carbonate blebs. Carbonate forms a mosaic of interlocking anhedral grains.

Map No. 1170
Sample No. 4-39-64B
Apatite - magnetite - biotite - amphibole sovite.

Fine grained, massive, hypidiomorphic. Apatite occurs as anhedral to subhedral grains, rounded to rounded-elongate in outline. Apatite grains tend to occur in

clusters. Magnetite is anhedral to subhedral in form and in places encloses apatite and blebs of carbonate; it is disseminated throughout. Biotite forms tabular ragged grains, with brown cores and dark reddish-brown rims. Edges appear ragged and worm eaten. Some biotite partially encloses carbonate grains. Amphibole forms acicular needle-like euhedral crystals. Amphibole is pleochroic in pale blue-green. Anhedral carbonate grains form an interlocking mosaic.

Map No. 1171
Sample No. 4-64-90A
Biotite- and magnetite-bearing, amphibole - apatite sovite.

Fine grained, massive, equigranular, hypiodiomorphic. Amphibole forms long, needle-like, euhedral, pleochroic pale green crystals. Apatite forms anhedral, rounded to rounded-elongate grains. Magnetite is anhedral to subhedral and disseminated throughout. Minor biotite has pale brown phlogopite cores and dark reddish-brown rims. Anhedral grains of carbonate form an interlocking mosaic.

Map No. 1172
Sample No. 4-90-116A
Amphibole-bearing, biotite - apatite - magnetite sovite.

Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Amphibole forms very fine grained aggregates of fibres. Anhedral grains of carbonate form an interlocking mosaic. Biotite forms ragged anhedral grains, sometimes tabular in outline; larger grains have a pale brown cores with dark reddish-brown rims. In places it encloses apatite and carbonate. Magnetite is anhedral to euhedral in form and locally encloses apatite and carbonate. Apatite forms rounded to rounded-elongate crystals, anhedral to subhedral in form.

Map No. 1173
Sample No. 4-90-116B
Sovite.

Fine grained, massive, equigranular, hypidiomorphic with curved grain boundaries. Carbonate forms an interlocking mosaic of anhedral grains. Carbonate is clear and fresh in appearance.

Map No. 1174
Sample No. 4-116-142A
Magnetite - apatite - biotite sovite.

Fine grained, massive, equigranular, hypidiomorphic. Apatite forms anhedral to subhedral, rounded to rounded-elongate grains. Rare pyrochlore is present as euhedral pale brown grains. Biotite forms anhedral to euhedral, ragged to tabular grains with brown cores and darker reddish-brown rims. Carbonate forms an interlocking mosaic of anhedral grains.

Map No. 1175
Sample No. 4-116-142B
Biotite sovite.

Fine grained, massive, inequigranular-seriate, allotriomorphic, with curved grain boundaries. Amphibole forms several euhedral colourless grains, which under crossed nicols appear to be zoned due to variations in birefringence. Biotite occurs as reddish-brown small tabular grains which appear to be concentrated in zones traversing the section, and which may represent zones of crushing. Carbonatite forms an interlocking mosaic of anhedral grains. Zones of finer grained carbonate traverse the section and may represent crushed zones. Carbonate in core box has weathered to rusty brown, but in thin section there is no visual difference between this carbonate and carbonate that did not weather to rusty brown.

Map No. 1176
Sample No. 4-142-170A
Biotite-bearing, apatite sovite.

Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Apatite forms rounded to rounded-elongate, anhedral to subhedral grains. Apatite often occurs as granular aggregates. Biotite forms anhedral to euhedral grains with pale brown cores and dark reddish-brown rims. It also occurs as clusters of small reddish-brown grains. Traces of disseminated magnetite are present.

Map No. 1177
Sample No. 4-142-170B
Apatite-bearing, biotite sovite.

Fine grained, massive, equigranular, hypidiomorphic. Biotite forms tabular to ragged grains with pale brown phlogopitic cores rimmed by dark reddish-brown ragged biotite that has a worm eaten appearance. On some grains, pale brown euhedral phlogopite-biotite has overgrown the dark reddish-brown rim. Apatite forms rounded anhedral grains, which are often elongated. Carbonate forms an interlocking mosaic of anhedral grains with curved grain boundaries.

Map No. 1178
Sample No. 4-313-441A
Biotite - amphibole - magnetite silicocarbonatite.

Fine to coarse grained, massive, inequigranular-seriate, hypidiomorphic. Biotite forms small tabular reddish-brown grains, interstitial to amphibole grains and along margins of magnetite grains. Magnetite forms anhedral to euhedral grains disseminated throughout. Larger grains may enclose rounded blebs of carbonate and some grains contain small grains of biotite in association with carbonate inclusions. Amphibole forms acicular grains which are interlocking or form a crude mesh. Carbonate grains are anhedral, forming an interlocking mosaic.

Map No. 1179
Sample No. 4-313-441B
Apatite - biotite - magnetite sovite.

Fine grained, massive, equigranular, hypidiomorphic. Apatite forms rounded anhedral grains some of which are elongate in outline. Amphibole forms elongate needle-like crystals; some twinning is present. Magnetite forms anhedral grains disseminated throughout. Biotite forms ragged anhedral to subhedral grains; larger grains are zoned with pale brown cores to dark reddish-brown rims. Carbonate forms an interlocking mosaic of subhedral grains.

Map No. 1180
Sample No. 4-341-369A
Magnetite - amphibole - biotite silicocarbonatite.

Fine grained, massive, equigranular, hypidiomorphic. Amphibole forms acicular, euhedral crystals, pleochroic in pale green. Larger crystals have colourless cores. Magnetite is anhedral to subhedral, and disseminated throughout. Biotite forms reddish-brown, anhedral to euhedral crystals. Smaller grains tend to be tabular. Larger grains are ragged with pale brown phlogopite cores and reddish-brown rims. Carbonate forms an interlocking mosaic of anhedral grains.

Map No. 1181
Sample No. 4-395-420A
Apatite - amphibole - biotite sovite.

Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Apatite forms rounded to rounded-elongate anhedral grains. Amphibole forms needle-like, pleochroic (pale blue-green), euhedral crystals. Biotite forms dark

brown, tabular, anhedral crystals, intergranular to carbonate and amphibole grains. Traces of magnetite are present.

Map No. 1182
Sample No. 4-395-420B
Amphibole-, apatite- and magnetite-bearing sovite.

Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Apatite forms rounded, anhedral to subhedral grains, often elongate in form. Amphibole forms scattered isolated grains and small aggregates of grains. Amphibole is acicular in form, and is pleochroic in pale green. Magnetite forms isolated, small, disseminated, anhedral grains. Carbonate forms an interlocking mosaic of anhedral grains with curved grain boundaries.

Map No. 1183
Sample No. 4-472-490A
Apatite - magnetite - amphibole - biotite sovite.

Fine grained, massive, equigranular, hypidiomorphic. Biotite forms anhedral ragged grains with pale brown phlogopite cores and dark reddish-brown biotite rims. Locally it encloses rounded blebs of carbonate. Magnetite forms anhedral to subhedral, disseminated grains. Amphibole forms acicular, euhedral crystals with pale green pleochroic rims and colourless cores. This zoning is restricted to the larger amphibole grains. Apatite forms rounded to rounded-elongate, anhedral grains. Carbonate forms an interlocking mosaic of anhedral grains.

Map No. 1184
Sample No. H2-99
Apatite - magnetite - phlogopite-biotite sovite.

Fine to medium grained, massive, equigranular, allotriomorphic, with straight to curved grain boundaries. Phlogopite-biotite forms anhedral, tabular to irregular grains with scalloped margins. Cores of grains are pale yellow brown (phlogopite) and rims are dark reddish-brown (biotite). Mineral has bent (001) cleavage. Magnetite is anhedral, disseminated and may contain poikilitic biotite. Apatite is anhedral, subrounded, and disseminated throughout. Anhedral carbonate grains form an interlocking mosaic.

Map No. 1185
Sample No. H2-283
Magnetite-bearing, phlogopite-biotite sovite.

Fine grained, massive, equigranular, massive, allotriomorphic, with straight to curved grain boundaries. Magnetite forms anhedral to subhedral, disseminated grains. Phlogopite-biotite forms tabular anhedral grains. Cores are pale yellow brown and rims are dark reddish-brown. Anhedral carbonate grains form an interlocking mosaic.

Map No. 1186
Sample No. H2-317
Amphibole - magnetite silicocarbonatite.

Fine to coarse grained, inequigranular-seriate, hypidiomorphic. Magnetite forms anhedral to euhedral crystals. One tiny grain of possible pyrochlore is perched on a grain of magnetite. Amphibole forms acicular crystals. Carbonate forms an interlocking mosaic of anhedral grains.

Map No. 1187
Sample No. H2-367
Sovite.

Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Carbonate forms an interlocking mosaic of grains. There are two types of carbonate: one clear and the other turbid with dusty hematite inclusions.

Map No. 1188
Sample No. H3-160
Amphibole-, magnetite- and phlogopite-biotite bearing, apatite sovite.

Fine grained, massive, inequigranular-seriate, allotriomorphic, with straight to curved grain boundaries. Amphibole forms acicular, euhedral, pale green crystals. Apatite occurs as anhedral grains scattered throughout. Some are elongate in outline. Magnetite is anhedral, and disseminated; it may enclose blebs of carbonate. Phlogopite-biotite forms anhedral to subhedral irregular grains with pale yellow-brown cores and dark reddish-brown rims. Some ragged biotite is present which may be after former pyroxene. Carbonate grains form an interlocking mosaic.

Map No. 1189
Sample No. H4-44
Apatite - fluorite sovite.

Fine grained, massive, equigranular, allotriomorphic, with straight to curved grain boundaries. Carbonate forms anhedral, irregular, interlocking grains. Apatite forms subhedral to euhedral crystals, some crystals are zoned from dark grey cores to light grey rims under crossed nicols. Fluorite is anhedral, interstitial to carbonate and partially encloses carbonate. Narrow, fine-grained, birefringent rims on some carbonate grains suggest a reaction relationship between fluorite and carbonate. Possible traces of pyrochlore.

Map No. 1190
Sample No. H4-119
Apatite - magnetite - phlogopite-biotite sovite.

Fine to medium grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Biotite forms ragged, anhedral grains with pale brown cores and reddish-brown rims. There are possible traces of pyrochlore. Amphibole forms fibrous aggregates of crystals. Apatite forms rounded, anhedral grains, commonly elongate in outline. Magnetite forms anhedral to euhedral, disseminated grains.

TABLE A-2. MAJOR ELEMENT ANALYSES OF WHOLE-ROCK SAMPLES FROM THE CARB LAKE CARBONATITE COMPLEX

	Sovite						
Map No.	**1165**	**1183**	**1172**	**1173**	**1159**	**1161**	**1160**
SiO_2	1.7	9.82	2.0	0.3	2.2	4.1	1.2
Al_2O_3	0.20	1.40	0.60	0.10	0.40	0.60	0.20
Fe_2O_3	1.04	2.56	2.44	0.09	1.52	3.02	3.80
FeO	2.30	4.00	2.03	0.64	2.86	6.37	3.42
MgO	3.30	8.00	3.10	1.60	3.90	11.5	2.60
CaO	49.6	36.9	47.6	52.8	46.1	31.2	47.4
Na_2O	0.16	0.75	0.08	0.03	0.08	0.22	0.08
K_2O	0.02	1.47	0.27	0.01	0.14	0.51	0.05
TiO_2	0.10	1.50	0.10	0.10	0.20	0.10	0.10
P_2O_5	1.12	4.28	4.84	0.61	2.70	8.64	3.60
S	0.44	0.22	0.17	0.01	0.06	0.04	0.04
MnO	0.40	0.32	0.21	0.17	0.45	0.60	0.30
CO_2	39.7	27.5	35.2	42.1	38.3	31.1	37.11
H_2O^+	0.10	0.02	0.02	0.04	0.09	0.02	0.01
H_2O^-	0.27	0.20	0.29	0.29	0.15	0.29	0.26

	Sovite						
Map No.	**1181**	**1171**	**1179**	**1175**	**1174**	**1176**	**1177**
SiO_2	1.3	2.7	2.8	1.1	0.9	0.8	1.7
Al_2O_3	0.10	0.30	0.40	0.10	0.20	0.20	0.50
Fe_2O_3	1.42	2.39	3.19	1.51	3.71	0.26	0.29
FeO	2.86	1.99	2.71	6.02	2.42	1.48	1.63
MgO	7.70	4.50	3.80	14.9	2.00	2.10	2.40
CaO	43.2	45.6	47.5	30.2	48.2	52.6	52.0
Na-O	0.11	0.27	0.16	0.03	0.08	0.03	0.03
K_2O	0.01	0.12	0.24	0.07	0.17	0.10	0.07
TiO_2	0.10	0.10	0.20	0.10	0.10	0.10	0.10
P_2O_5	2.22	4.00	4.76	2.50	3.18	2.05	0.70
S	0.26	0.11	0.28	0.27	0.17	0.14	0.15
MnO	0.55	0.26	0.31	0.45	0.21	0.29	0.31
CO_2	39.8	36.6	34.1	42.0	36.8	40.8	41.3
H_2O^+	0.01	0.02	0.02	0.01	0.03	0.01	0.04
H_2O^-	0.26	0.46	0.24	0.43	0.36	0.22	0.11

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Map No.	Sample No.	Map No.	Sample No.
1165	3-312-337D	1181	4-395 420A
1183	4-472 490A	1171	4-64 90A
1172	4-90 116A	1179	4-313 441B
1173	4-90 116B	1175	4-116 142B
1159	3-107 135C	1174	4-116 142A
1161	3-186 210C	1176	4-142 170A
1160	3-186 210B	1177	4-142 170B

TABLE A-2 Continued.

	SOVITE						
Map No.	**1164**	**1162**	**1155**	**1170**	**1182**	**1163**	**1169**
SiO_2	5.8	0.9	0.2	4.2	0.3	5.5	2.0
Al_2O_3	0.90	0.20	0.10	0.30	0.10	0.60	0.30
Fe_2O_3	0.90	0.34	0.54	1.07	1.41	2.64	3.77
FeO	5.31	2.30	4.64	1.56	4.67	4.37	2.82
MgO	14.1	2.80	16.3	4.50	16.1	5.70	3.70
CaO	30.6	49.6	32.5	46.6	30.6	41.4	46.4
Na_2O	0.30	0.03	0.05	0.19	0.01	0.27	0.03
K_2O	1.09	0.07	0.05	0.22	0.02	0.75	0.12
TiO_2	0.10	0.10	0.10	0.10	0.10	0.80	0.10
P_2O_5	7.32	3.68	1.92	4.56	2.70	2.60	2.94
S	0.01	0.08	0.01	0.07	0.10	0.24	0.17
MnO	0.51	0.38	0.77	0.21	0.61	0.35	0.24
CO_2	32.0	39.6	43.1	36.5	43.4	35.4	37.6
H_2O^+	0.01	0.07	0.01	0.14	0.01	0.71	0.26
H_2O^-	0.28	0.25	0.31	0.40	0.23	0.31	0.15

	SOVITE				
Map No.	**1184**	**1185**	**1187**	**1188**	**1189**
SiO_2	3.43	1.69	1.16	2.07	2.90
Al_2O_3	0.67	0.34	0.25	0.36	0.41
Fe_2O_3	6.40	0.55	0.77	5.65	1.55
FeO	5.72	1.13	3.38	5.23	2.42
MgO	14.48	1.33	14.33	2.87	3.61
CaO	28.40	50.60	34.40	42.20	47.00
Na_2O	0.33	0.57	0.23	0.67	0.71
K_2O	0.56	0.08	0.0	0.09	0.18
TiO_2	0.02	0.0	0.0	0.01	0.09
P_2O_5	2.72	1.68	0.07	2.76	2.82
S	0.05	0.09	0.01	0.21	0.13
MnO	0.48	0.16	0.72	0.29	0.22
CO_2	32.60	41.90	46.10	37.80	36.90
H_2O^+	0.0	0.0	0.0	0.0	0.0
H_2O^-	0.28	0.0	0.36	0.0	0.0

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Map No.	Sample No.	Map No.	Sample No.
1164	3-285 312C	1184	H2-99
1162	3-234 259A	1185	H2-283
1155	3-53 82A	1187	H2-367
1170	4-39 64B	1188	H3-160
1182	4-395 420B	1189	H4-44
1163	3-234 259B		
1169	4-39 64A		

TABLE A-2 Continued.

	SOVITE				
Map No.	**1190**	**1154**	**1167**	**1157**	**1158**
SiO_2	2.51	3.0	4.8	3.8	8.7
Al_2O_3	0.46	1.10	0.80	0.50	1.10
Fe_2O_3	1.23	41.7	35.4	42.9	43.6
FeO	2.25	16.6	19.2	14.7	14.8
MgO	2.39	3.80	6.40	2.80	5.40
CaO	48.00	15.9	12.9	18.3	9.50
Na_2O	0.58	0.30	0.27	0.27	0.81
K_2O	0.21	0.41	0.75	0.48	1.28
TiO_2	0.0	0.80	0.10	1.60	1.60
P_2O_5	2.00	7.92	1.40	11.9	3.23
S	0.09	0.06	0.03	0.02	1.30
MnO	0.18	0.21	0.40	0.13	0.22
CO_2	39.50	5.50	14.8	2.00	6.80
H_2O^+	0.0	0.91	0.05	0.41	0.17
H_2O^-	0.0	0.27	0.26	0.13	0.23

	SILICOCARBONATITE				
Map No.	**1178**	**1180**	**1168**	**1166**	**1186**
SiO_2	9.06	24.8	24.0	18.6	6.75
Al_2O_3	0.20	3.10	2.00	2.00	0.46
Fe_2O_3	32.1	9.44	10.1	8.71	46.06
FeO	13.8	9.86	9.04	9.26	19.30
MgO	8.30	14.2	15.2	14.9	5.53
CaO	16.1	13.8	13.0	15.8	7.95
Na_2O	1.21	1.86	2.43	1.56	1.47
K_2O	0.29	1.14	2.41	2.60	0.35
TiO_2	0.90	2.80	1.90	2.00	0.49
P_2O_5	4.06	0.38	0.30	0.98	0.03
S	2.46	0.46	1.00	0.09	0.03
MnO	0.31	0.36	0.42	0.54	0.44
CO_2	13.3	15.6	18.4	21.8	12.10
H_2O^+	0.12	0.16	0.57	0.60	0.0
H_2O^-	0.23	0.46	0.29	0.29	0.33

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Map No.	Sample No	Map No.	Sample No.
1190	H4-119	1178	4-313 441A
1154	3-53 82B	1180	4-341 369A
1167	3-414 439B	1168	3-439 454B
1157	3-82 107A	1166	3-363 395A
1158	3-107 135B	1186	H2-317

TABLE A-3. TRACE ELEMENT ANALYSES OF WHOLE-ROCK SAMPLES FROM THE CARB LAKE CARBONATITE COMPLEX

	SOVITE					
Map No.	**1165**	**1183**	**1172**	**1173**	**1159**	**1161**
Ag	<1	<1	<1	<1	<1	<1
Au						
As						
Ba	480	290	630	300	350	890
Be	<1	4	<1	<1	<1	3
Bi						
Co	10	10	10	<5	10	7
Cr	5	<5	<5	<5	20	5
Cu	6	20	20	<5	15	7
Ga	<3	10	3	<3	3	15
Hg						
Li	10	25	8	<3	20	20
Mn	3140	2490	1600	1340	3500	4650
Mo	<3	<3	<3	<3	<3	<3
Nb	>0.1%	200	70	<30	300	>0.1%
Ni	<5	<5	<5	6	7	<5
Pb	65	55	25	25	40	50
Rb	<10	60	20	<10	10	30
Sb						
Sc	20	35	20	6	20	30
Sn	<3	<3	<3	<3	6	6
Sr	3600	2800	3200	4720	2430	2700
Ti						
V	<10	45	35	<10	20	<10
Y	100	80	100	60	150	100
Zn	30	60	50	6	25	5
Zr	60	350	150	<10	150	200
La	300	350	450	250	350	400
Nd	<300	<300	300	<300	<300	<300
Ce	540	670	600	520	680	630

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Map No.	Sample No.	Map No.	Sample No.
1165	3-312-337D	1173	4-90 116B
1183	4-472 490A	1159	3-107 135C
1172	4-90 116A	1161	3-186 210C

TABLE A-3 Continued.

Map No.	SOVITE					
	1160	1181	1171	1179	1175	1174
Ag	<1	<1	<1	<1	<1	<1
Au						
As						
Ba	460	410	370	510	490	720
Be	4	<1	3	<1	<1	<1
Bi						
Co	<5	6	7	10	7	7
Cr	<5	<5	<5	5	10	5
Cu	7	5	20	6	<5	8
Ga	3	<3	<3	3	<3	<3
Hg						
Li	8	4	6	6	5	5
Mn	2300	4300	2000	2430	3500	1600
Mo	<3	<3	<3	<3	<3	<3
Nb	400	700	70	500	350	>7.1%
Ni	<5	<5	<5	<5	<5	<5
Pb	<10	50	20	75	35	70
Rb	<10	<10	10	20	<10	<10
Sb						
Sc	20	15	20	20	6	10
Sn	<3	<3	<3	<3	<3	<3
Sr	3800	4100	3000	4200	5000	3600
Ti						
V	<10	<10	50	70	30	25
Y	150	90	100	100	40	100
Zn	85	30	70	35	135	110
Zr	200	200	200	100	25	200
La	350	500	400	500		400
Nd	<300	300	<300	<300	<300	<300
Ce	480	750	670	630	5620	660

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Map No.	Sample No.	Map No.	Sample No.
1160	3-186 210B	1179	4-313 441B
1181	4-395 420A	1175	4-116 142B
1171	4-64 90A	1174	4-116 142A

TABLE A-3 Continued.

	SOVITE					
Map No.	**1176**	**1177**	**1164**	**1162**	**1155**	**1170**
Ag	<1	<1	<1	<1	<1	<1
Au						
As						
Ba	480	700	70	520	120	750
Be	<1	<1	8	<1	<1	4
Bi						
Co	7	10	9	<5	6	8
Cr	5	5	25	<5	5	<5
Cu	10	10	6	8	<5	25
Ga	<3	4	15	<3	<3	<3
Hg						
Li	4	4	30	5	4	9
Mn	2240	2420	3990	3000	5950	1650
Mo	<3	10	<3	<3	<3	<3
Nb	30	200	700	400	400	<30
Ni	<5	<5	5	<5	<5	<5
Pb	65	75	35	195	35	40
Rb	<10	20	40	<10	10	10
Sb						
Sc	10	6	20	5	3	25
Sn	<3	<3	<3	<3	<3	<3
Sr	4400	4200	2400	4130	2300	2300
Ti						
V	<10	<10	20	<10	<10	25
Y	100	100	150	100	20	100
Zn	145	125	40	160	25	15
Zr	10	25	50	100	25	200
La	400	500	300	400	250	400
Nd	<300	<300	<300	<300	<300	<300
Ce	590	670	350	550	330	530

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Map No.	Sample No.	Map No.	Sample No.
1176	4-142 170A	1162	3-234 259A
1177	4-142 170B	1155	3-53 82A
1164	3-285 312C	1170	4-39 64B

TABLE A-3 Continued.

	SOVITE					
Map No.	**1182**	**1163**	**1169**	**1184**	**1185**	**1187**
Ag	<1	<1	<1	<1	<1	<1
Au						
As						
Ba	100	280	730	150	970	110
Be	<1	4	2			
Bi						
Co	5	20	10	6	6	<5
Cr	7	15	7	5	5	<5
Cu	<5	35	70	8	10	8
Ga	9	<3	4	5	1	<1
Hg						
Li	4	40	10	7	<3	<3
Mn	4800	2760	1850			
Mo	<3	<3	<3	<1	3	<1
Nb	800	300	150	1500	1500	<30
Ni	<5	10	<5	<5	<5	<5
Pb	30	30	25	<10	29	<10
Rb	<10	30	10	30	<10	<10
Sb						
Sc	10	20	25	15	9	<5
Sn	<3	<3	<3	10	<3	<3
Sr	3000	2400	2500	2500	3000	900
Ti						
V	<10	70	100	20	<10	<10
Y	35	100	150	60	80	<10
Zn	25	100	70	104	202	18
Zr	35	200	150	3000	150	<10
La	250	400	450	150	250	100
Nd	<300	<300	<300	300	150	<100
Ce	170	700	590	370	370	140

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Map No.	Sample No.	Map No.	Sample No.
1182	4-395 420B	1184	H2-99
1163	3-234 259B	1185	H2-283
1169	4-39 64A	1187	H2-367

TABLE A-3 Continued.

	SOVITE					
Map No.	**1188**	**1189**	**1190**	**1154**	**1167**	**1157**
Ag	<1	<1	<1	<3	10	<3
Au						
As						
Ba	690	520	800	550	510	330
Be				<3	<3	<3
Bi						
Co	<5	8	13	15	10	10
Cr	11	9	<5	15	9	15
Cu	11	30	22	8	8	6
Ga	2	2	2	20	15	25
Hg						
Li	5	10	7	25	15	25
Mn				1660	3100	1080
Mo	<1	<1	<1	<3	<3	<3
Nb	1000	90	500	>0.1%	>0.1%	>0.1%
Ni	<5	<5	<5	9	9	<5
Pb	17	<10	41	105	40	50
Rb	<10	<10	10	20	20	20
Sb						
Sc	20	25	15	45	42	15
Sn	6	<3	<3	45	30	40
Sr	4000	3500	4000	2300	730	1900
Ti						
V	150	60	25	155	100	400
Y	100	90	100	70	45	80
Zn	90	37	54	40	50	55
Zr	150	450	100	900	1000	600
La	300	300	400	<300	<300	<300
Nd	250	200	250	<300	<300	<300
Ce	670	340	630	560	390	800

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Map No.	Sample No	Map No.	Sample No
1188	H3-160	1154	3-53 82B
1189	H4-44	1167	3-414 439B
1190	H4-119	1157	3-82 107A

TABLE A-3 Continued.

	SOVITE	SILICOCARBONATITE				
Map No.	1158	1178	1180	1168	1166	1186
Ag	<3	<3	<1	<1	<1	<1
Au						
As						
Ba	490	70	270	190	90	290
Be	10	<3	8	10	7	
Bi						
Co	55	80	40	60	40	23
Cr	15	30	310	480	400	9
Cu	40	60	140	125	110	8
Ga	30	6	15	15	8	7
Hg						
Li	55	8	115	65	120	6
Mn	1720	2390	2760	3260	4190	
Mo	<3	<3	<3	<3	<3	6
Nb		400	250	150	300	700
	>0.1%					
Ni	<5	6	125	320	440	<5
Pb	400	40	25	40	50	<10
Rb	40	<10	110	60	110	<10
Sb						
Sc	35	70	70	100	70	25
Sn	50	20	<3	4	<3	20
Sr	890	1300	560	710	1100	400
Ti						
V	450	250	150	100	100	150
Y	45	45	15	<10	15	10
Zn	35	240	80	80	60	124
Zr	600	150	250	100	150	450
La	<300	<300	150	150	<100	<100
Nd	<300	<300	<300	<300	<300	<100
Ce	580	490	560	420	360	<50

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Map No.	Sample No.	Map No.	Sample No.
1158	3-107 135B	1168	3-439 454B
1178	4-313 441A	1166	3-363 395A
1180	4-341 369A	1186	H2-317

TABLE A-4. NORMATIVE MINERALS (ALKALIC ROCKS) FOR WHOLE-ROCK SAMPLES FROM THE CARB LAKE CARBONATITE COMPLEX

	SOVITE					
Map No.	**1165**	**1183**	**1172**	**1173**	**1159**	**1161**
Quartz	0.0	0.0	0.12	0.0	0.70	0.0
Corundum	0.18	0.0	0.31	0.10	0.25	0.0
Orthoclase	0.0	5.54	1.59	0.0	0.83	0.0
Albite	0.0	0.0	0.0	0.0	0.0	0.0
Leucite	0.0	1.64	0.0	0.0	0.0	0.0
Kalsilite	0.07	0.0	0.0	0.0	0.0	1.67
Nepheline	0.0	0.0	0.0	0.0	0.0	0.17
Carnegieite	0.0	0.0	0.0	0.0	0.0	0.0
Na_2SiO_3	0.0	0.0	0.0	0.0	0.0	0.0
Acmite	0.0	0.0	0.0	0.0	0.0	0.0
Thenardite	0.37	1.72	0.18	0.07	0.18	0.44
Gehlenite	0.0	0.0	0.0	0.0	0.0	0.0
Akermanite	0.72	0.0	0.0	0.45	0.0	4.67
Fe-Aker.	0.66	0.0	0.0	0.52	0.0	3.39
Wollastonite	−1.11	0.0	0.0	−0.78	0.0	−6.55
Enstatite	−0.53	0.0	0.0	−0.33	0.0	−3.42
Ferrosilite	−0.57	0.0	0.0	−0.45	0.0	−2.94
Forsterite	2.84	9.31	0.86	0.83	0.0	9.59
Fayalite	3.40	4.50	1.63	1.27	3.18	9.11
Andradite	0.0	0.0	0.0	0.0	0.0	0.0
Hematite	0.0	0.0	0.0	0.0	0.0	0.0
Magnetite	1.51	3.72	3.54	0.13	2.21	4.39
Sphene	0.0	0.0	0.0	0.0	0.0	0.0
Perovskite	0.0	0.0	0.0	0.0	0.0	0.0
Rutile	0.10	1.50	0.10	0.10	0.02	0.10
Apatite	2.65	9.94	11.46	1.44	6.39	1.51
Calcite	85.82	55.94	73.51	92.72	75.86	54.13
Magnesite	3.69	5.50	5.43	2.47	8.13	13.89
Fluorite	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.0	0.0	0.0	0.0	0.0	0.0
Baddeleyite	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.37	0.22	0.31	0.33	0.24	0.31
Sum	100.15	99.53	99.04	98.88	97.98	90.46

Notes: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Map No.	Sample No.	Map No.	Sample No.
1165	3-312-337D	1173	4-90 116B
1183	4-472 490A	1159	3-107 135C
1172	4-90 116A	1161	3-186 210C

TABLE A-4 Continued.

	SOVITE					
Map No.	**1160**	**1181**	**1171**	**1179**	**1175**	**1174**
Quartz	0.13	0.02	1.72	0.0	0.0	0.0
Corundum	0.15	0.10	0.17	0.14	0.02	0.0
Orthoclase	0.30	0.0	0.71	0.0	0.0	0.0
Albite	0.0	0.0	0.0	0 0	0.0	0.0
Leucite	0.0	0.0	0.0	0.0	0.0	0.0
Kalsilite	0.0	0.0	0.0	0.81	0.23	0.57
Nepheline	0.0	0.0	0.0	0.0	0.0	0.0
Carnegieite	0.0	0.0	0.0	0.0	0.0	0.0
Na_2SiO_3	0.0	0.0	0.0	0.0	0.0	0.0
Acmite	0.0	0.0	0.0	0.0	0.0	0.0
Thenardite	0.18	0.25	0.62	0.37	0.07	0.18
Gehlenite	0.0	0.0	0.0	0.0	0.0	0.04
Akermanite	0.0	0.0	0.0	0.37	0.0	16.40
Fe-Aker.	0.0	0.0	0.0	0.27	4.83	13.49
Wollastonite	0.0	0.0	0.0	−0.52	−3.69	−14.56
Enstatite	0.0	0.0	0.0	−0.27	0.0	−7.22
Ferrosilite	0.0	0.0	0.0	−0.23	−4.20	−7.04
Forsterite	0.0	0.34	0.0	3.92	0.0	4.32
Fayalite	2.87	3.94	1.67	3.77	9.85	4.65
Andradite	0.0	0.0	0.0	0.0	0.0	0.0
Hematite	0.0	0.0	0.0	0.0	0.0	3.72
Magnetite	5.52	2.06	3.47	4.63	2.19	0.0
Sphene	0.0	0.0	0.0	0.0	0.0	0.0
Perovskite	0.0	0.0	0.0	0.0	0.0	0.17
Rutile	0.10	0.10	0.10	0.20	0.10	0.0
Apatite	8.52	5.25	9.47	11.27	5.92	7.53
Calcite	76.07	71.82	71.92	73.53	47.98	69.98
Magnesite	5.42	15.64	9.38	3.33	31.05	0.0
Fluorite	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.0	0.0	0.0	0.0	0.0	0.0
Baddeleyite	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.26	0.26	0.48	0.26	0.43	0.39
Sum	99.52	99.79	99.70	101.82	94.80	92.63

Notes: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Map No.	Sample No.	Map No.	Sample No.
1160	3-186 210B	1179	4-313 441B
1181	4-395 420A	1175	4-116 142B
1171	4-64 90A	1174	4-116 142A

TABLE A-4 Continued.

	SOVITE					
Map No.	**1176**	**1177**	**1164**	**1162**	**1155**	**1170**
Quartz	0.0	0.0	0.0	0.0	0.0	2.63
Corundum	0.09	0.21	0.0	0.12	0.03	0.06
Orthoclase	0.0	0.0	1.25	0.0	0.0	1.30
Albite	0.0	0.0	0.0	0.0	0.0	0.0
Leucite	0.0	0.0	2.87	0.0	0.0	0.0
Kalsilite	0.34	0.91	0.0	0.23	0.15	0.0
Nepheline	0.0	0.0	0.0	0.0	0.07	0.0
Carnegieite	0.0	0.0	0.0	0.0	0.0	0.0
Na_2SiO_3	0.0	0.0	0.0	0.0	0.0	0.0
Acmite	0.0	0.0	1.95	0.0	0.0	0.0
Thenardite	0.07	0.07	0.09	0.07	0.09	0.44
Gehlenite	0.0	0.0	0.0	0.0	0.0	0.0
Akermanite	0.59	0.63	0.0	0.0	0.0	0.0
Fe-Aker.	1.02	0.55	0.0	0.80	6.92	0.0
Wollastonite	−1.28	−0.96	0.0	−0.61	−5.28	0.0
Enstatite	−0.43	−0.46	0.0	0.0	0.0	0.0
Ferrosilite	−0.88	−0.48	0.0	−0.70	−6.01	0.0
Forsterite	1.19	2.40	0.0	0.0	0.07	0.43
Fayalite	2.69	2.76	8.13	3.86	9.67	1.83
Andradite	0.0	0.0	0.0	0.0	0.0	0.0
Hematite	0.0	0.0	0.0	0.0	0.0	0.0
Magnetite	0.38	0.42	0.33	0.49	0.78	1.55
Sphene	0.0	0.0	0.0	0.0	0.0	0.0
Perovskite	0.0	0.0	0.0	0.0	0.0	0.0
Rutile	0.10	0.10	0.10	0.10	0.10	0.10
Apatite	4.85	1.66	17.33	8.71	2.41	10.79
Calcite	88.98	91.08	37.38	79.80	55.56	72.39
Magnesite	3.13	2.32	29.38	5.83	33.97	8.86
Fluorite	0.0	0.0	0.0	0.0	0.07	0.0
Zircon	0.0	0.0	0.0	0.0	0.0	0.0
Baddeleyite	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.22	0.15	0.28	0.32	0.31	0.54
Sum	101.05	101.35	99.08	99.05	98.77	100.92

Notes: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Map No.	Sample No.	Map No.	Sample No.
1176	4-142 170A	1162	3-234 259A
1177	4-142 170B	1155	3-53 82A
1164	3-285 312C	1170	4-39 64B

TABLE A-4 Continued.

	SOVITE					
Map No.	**1182**	**1163**	**1169**	**1184**	**1185**	**1187**
Quartz	0.0	2.74	0.97	0.0	0.22	0.0
Corundum	0.08	0.0	0.17	0.0	0.05	0.0
Orthoclase	0.0	3.27	0.71	0.0	0.47	0.0
Albite	0.0	0.0	0.0	0.0	1.06	0.0
Leucite	0.0	0.0	0.0	0.0	0.0	0.0
Kalsilite	0.07	0.0	0.0	1.81	0.0	0.0
Nepheline	0.0	0.0	0.0	0.24	0.0	0.0
Carnegieite	0.0	0.0	0.0	0.0	0.0	0.70
Na_2SiO_3	0.0	0.0	0.0	0.0	0.0	0.0
Acmite	0.0	0.0	0.0	0.30	0.0	0.15
Thenardite	0.0	0.62	0.07	0.58	1.02	0.13
Gehlenite	0.0	0.0	0.0	0.0	0.0	0.0
Akermanite	0.0	0.0	0.0	1.30	0.0	0.0
Fe-Aker.	5.54	0.0	0.0	1.11	0.0	2.68
Wollastonite	−4.22	0.0	0.0	−1.95	0.0	−2.05
Enstatite	0.0	0.0	0.0	−0.95	0.0	0.0
Ferrosilite	−4.81	0.0	0.0	−0.97	0.0	−2.33
Forsterite	0.0	1.00	0.0	4.60	0.0	0.0
Fayalite	8.46	0.60	1.94	5.16	1.48	6.27
Andradite	0.0	0.0	0.0	0.0	0.0	0.0
Hematite	0.0	0.0	0.0	0.0	0.0	0.0
Magnetite	2.05	3.84	5.48	9.15	0.80	1.04
Sphene	0.0	0.0	0.0	0.0	0.0	0.0
Perovskite	0.0	0.0	0.0	0.0	0.0	0.0
Rutile	0.10	0.80	0.10	0.02	0.0	0.0
Apatite	6.39	6.15	6.96	6.44	3.98	0.17
Calcite	48.22	67.72	75.84	44.25	86.28	61.18
Magnesite	33.55	10.68	7.71	25.05	2.77	29.86
Fluorite	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.0	0.0	0.0	0.0	0.0	0.0
Baddeleyite	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.23	1.02	0.41	0.28	0.0	0.36
Sum	95.66	98.44	100.35	96.43	98.13	98.17

Notes: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Map No.	Sample No.	Map No.	Sample No.
1182	4-395 420B	1184	H2-99
1163	3-234 259B	1185	H2-283
1169	4-39 64A	1187	H2-367

TABLE A-4 Continued.

	SOVITE					
Map No.	**1188**	**1189**	**1190**	**1157**	**1158**	**1167**
Quartz	0.0	0.29	0.13	0.0	0.0	0.0
Corundum	0.0	0.10	0.01	0.0	0.0	0.0
Orthoclase	0.06	1.06	1.24	0.0	0.0	0.92
Albite	0.01	0.61	1.14	0.0	0.0	0.0
Leucite	0.0	0.0	0.0	1.43	0.0	2.70
Kalsilite	0.0	0.0	0.0	0.51	3.41	0.0
Nepheline	0.99	0.0	0.0	0.0	0.0	0.0
Carnegieite	0.0	0.0	0.0	0.0	0.0	0.0
Na_2SiO_3	0.0	0.0	0.0	0.0	0.0	0.0
Acmite	0.63	0.0	0.0	1.29	0.0	1.00
Thenardite	0.93	1.46	1.02	0.22	1.86	0.31
Gehlenite	0.0	0.0	0.0	0.0	0.0	0.0
Akermanite	0.0	0.0	0.0	0.0	6.95	0.0
Fe-Aker.	0.0	0.0	0.0	0.0	3.20	0.0
Wollastonite	0.0	0.0	0.0	0.0	−1.93	0.0
Enstatite	0.0	0.0	0.0	0.0	−1.18	0.0
Ferrosilite	0.0	0.0	0.0	0.0	−0.64	0.0
Forsterite	0.0	1.61	0.0	4.86	8.42	1.37
Fayalite	4.37	2.76	2.67	0.0	5.07	5.44
Andradite	0.0	0.0	0.0	0.0	0.0	0.0
Hematite	0.0	0.0	0.0	9.51	19.50	0.0
Magnetite	7.89	2.25	1.79	47.83	34.95	50.92
Sphene	0.0	0.0	0.0	0.28	0.0	0.0
Perovskite	0.0	0.0	0.0	0.0	2.72	0.0
Rutile	0.01	0.22	0.0	1.49	0.0	0.10
Apatite	6.53	6.68	4.73	28.17	7.65	3.31
Calcite	68.77	77.19	80.90	4.54	1.82	19.72
Magnesite	5.98	5.59	4.98	0.0	0.0	11.69
Fluorite	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.0	0.0	0.0	0.0	0.0	0.0
Baddeleyite	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.0	0.0	0.0	0.54	0.43	0.31
Sum	96.18	99.81	98.61	100.74	92.30	97.80

Notes: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Map No.	Sample No	Map No.	Sample No
1188	H3-160	1157	3-82 107A
1189	H4-44	1158	3-107 135B
1190	H4-119	1167	3-414 439B

TABLE A-4 Continued.

	SOVITE	SILICOCARBONATITE				
Map No.	**1154**	**1178**	**1180**	**1168**	**1166**	**1186**
Quartz	0.0	5.48	10.86	7.15	0.12	0.0
Corundum	0.64	0.0	1.87	0.0	0.0	0.0
Orthoclase	0.0	1.09	6.73	10.91	10.91	1.96
Albite	0.0	0.0	0.0	0.0	0.0	0.13
Leucite	1.63	0.0	0.0	0.0	0.0	0.0
Kalsilite	0.18	0.07	0.0	0.0	0.0	0.0
Nepheline	0.06	0.0	0.0	0.0	0.0	0.21
Carnegieite	0.0	0.0	0.0	0.0	0.0	0.0
Na_2SiO_3	0.0	0.0	0.0	0.0	0.0	0.0
Acmite	0.0	0.0	0.0	3.70	8.46	9.58
Thenardite	0.66	2.77	4.26	4.43	0.97	0.31
Gehlenite	0.0	0.0	0.0	0.0	0.0	0.0
Akermanite	0.0	0.0	0.0	0.0	0.0	0.0
Fe-Aker.	0.0	0.0	0.0	0.0	0.0	0.0
Wollastonite	0.0	0.0	0.0	0.0	0.0	0.0
Enstatite	0.0	0.0	0.0	0.0	0.0	0.0
Ferrosilite	0.0	0.0	0.0	0.0	0.0	0.0
Forsterite	4.68	6.68	16.45	12.86	9.31	0.23
Fayalite	0.0	0.0	8.49	7.87	10.23	0.73
Andradite	0.0	0.0	0.0	0.0	0.0	0.0
Hematite	4.68	0.63	0.0	0.0	0.0	0.0
Magnetite	53.80	45.57	13.71	12.67	8.41	62.10
Sphene	0.0	0.0	0.0	0.0	0.0	0.0
Perovskite	0.0	0.0	0.0	0.0	0.0	0.0
Rutile	0.80	0.90	2.80	1.90	2.00	0.49
Apatite	18.75	9.61	0.90	0.71	2.32	0.07
Calcite	9.75	19.18	23.72	22.48	25.87	14.11
Magnesite	2.30	9.28	9.85	16.24	19.88	11.25
Fluorite	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.0	0.0	0.0	0.0	0.0	0.0
Baddeleyite	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	1.18	0.35	0.62	0.86	0.89	0.33
Sum	99.11	101.54	100.26	101.78	99.36	101.50

Notes: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Map No.	Sample No.	Map No.	Sample No.
1154	3-53 82B	1168	3-439 454B
1178	4-313 441A	1166	3-363 395A
1180	4-341 369A	1186	H2-317

TABLE A-5. AVERAGE CHEMICAL COMPOSITIONS OF LITHOLOGIC UNITS FOR THE CARB LAKE CARBONATITE COMPLEX

	SOVITE (N = 31)			
	MEAN	MINIMUM	STANDARD DEVIATION	MAXIMUM
SiO_2	25.4	1.16	12.9	38.7
Al_2O_3	0.45	0.10	0.32	1.40
Fe_2O_3	8.24	0.09	14.9	46.1
FeO	5.35	0.64	5.33	19.3
MgO	6.17	1.33	4.81	16.3
CaO	38.2	7.95	13.3	52.8
Na_2O	0.29	0.01	0.32	1.47
K_2O	0.33	0.01	0.38	1.47
H_2O^+	0.13	0.01	0.23	0.91
H_2O^-	0.27	0.11	0.08	0.46
CO_2	33.3	2.00	11.8	46.1
TiO_2	0.31	0.01	0.47	1.60
P_2O_5	3.30	0.03	2.37	9.99
S	0.16	0.01	0.23	1.30
MnO	0.36	0.13	0.17	0.77
Ag	1	1	2	10
Au				
As				
Ba	471	70	235	970
Be	2	1	2	10
Bi				
Co	10	5	9	55
Cr	8	5	5	25
Cu	14	5	14	70
Ga	7	1	7	30
Hg				
Li	12	3	12	55
Mn				
Mo	3	1	2	10
Nb	438	30	419	1500
Ni	6	5	1	10
Pb	55	10	72	400
Rb	17	10	12	60
Sb				
Sc	18	3	10	42
Sn	9	3	13	50
Sr				
Ti				
V	66	10	104	450
Y	85	10	38	150
Zn	69	6	48	202
Zr	314	10	549	3000
Ce	770	170	1020	5620
La	335	100	104	500
Nd	277	100	57	300

Notes: For complete listing of statistical parameters, see Open File Report 5399.

TABLE A-5 Continued.

	SILICOCARBONATITE (N = 5)			
	MEAN	MINIMUM	STANDARD DEVIATION	MAXIMUM
SiO_2	19.1	9.06	7.25	24.8
Al_2O_3	1.83	0.20	1.20	3.10
Fe_2O_3	15.1	8.71	11.3	32.1
FeO	10.5	9.04	2.24	13.8
MgO	13.2	8.30	3.26	15.2
CaO	14.7	13.0	1.51	16.1
Na_2O	1.77	1.21	0.52	2.43
K_2O	1.61	0.29	1.09	2.60
H_2O^+	0.36	0.12	0.26	0.60
H_2O^-	0.32	0.23	0.10	0.46
CO_2	17.3	13.3	13.7	21.8
TiO_2	1.90	0.90	0.78	2.80
P_2O_5	1.43	0.30	1.78	4.06
S	1.00	0.09	1.04	2.46
MnO	0.41	0.31	0.10	0.54
Ag	2	1	1	3
Au				
As				
Ba	155	70	93	270
Be	7	3	3	10
Bi				
Co	55	40	19	80
Cr	305	30	196	480
Cu	109	60	35	140
Ga	11	6	5	15
Hg				
Li	77	8	52	120
Mn				
Mo	3	3	0	3
Nb	275	150	104	400
Ni	223	6	194	440
Pb	39	25	10	50
Rb	73	10	48	110
Sb				
Sc	78	70	15	100
Sn	8	3	8	20
Sr				
Ti				
V	150	100	71	250
Y	21	10	16	45
Zn	115	60	84	240
Zr	163	100	63	250
Ce	458	360	87	560
La	175	100	87	300
Nd	300	300	0	300

Notes: For complete listing of statistical parameters, see Open File Report 5399.

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Index

Amphibole 6
  Silicocarbonatite 16,18,19
  Sovite 14,15,16,17,18,19,20
  Sovite/silicocarbonatite 9
  Vugs 9,10
Analyses, average chemical compositions
  Silicocarbonatite 37
  Sovite 36
Analyses, major elements
  Silicocarbonatite 23
  Sovite 21-23
Analyses, normative minerals
  Silicocarbonatite 35
  Sovite 30-35
Analyses, trace elements
  Silicocarbonatite 29
  Sovite 24-29
Ancylite 9
Anomaly, aeromagnetic 3,6
  Map 7
Anomaly, radiometric 3
Apatite
  Sovite 14,15,16,17,18,19,20
  Sovite/silicocarbonatite 9,10
Archean 6

Banding
  Carbonatite 6,9,12
Big Nama Creek Mines Ltd. 6,13
Biotite
  Silicocarbonatite 16,18
  Sovite 14,15,16,17,18,19,20
  Sovite/silicocarbonatite 10
Biotite-phlogopite
  Reaction rims 11
  Sovite 16,17,18,19,20
  Sovite/silicocarbonatite 9-10
Biotitite 6

Calcite
  Carbonate phase 11
  Vug 10
Carbonate
  Silicocarbonatite 16,18,19
  Silicocarbonatite/biotitite 6
  Sovite 14,15,16,17,18,19,20
  Sovite/silicocarbonatite 9,10
  Vugs 6
Cerium
  Ancylite 9

Dolomite
  Vug 10
Dolomite, ferruginous
  Carbonate phase 11

Echoing River 6

Fluorite
  Sovite 20
  Sovite/silicocarbonatite 11
  Vugs 6

Garnet
  Sovite/silicocarbonatite 11
Geology 8
Geology, structural 12
Granitic gneiss 6

Hematite
  Carbonate 20
  see also Dolomite, ferruginous
Hematite
  Vug 10

International Minerals and Chemical Corp. 13
Isotopic age, K-Ar.
  Carb Lake Carbonatite Complex 6

Kenyon Structural Zone 6,12

Lanthanum
  Ancylite 9
Larandona Mines Ltd. 6,13
Leaching
  Vugs
    Prospecting 13
Lithologic units 9

Magnetite 3,6
  Silicocarbonatite 16,18,19
  Sovite 14,15,16,17,18,19,20
  Sovite/silicocarbonatite 9,10
  Vugs 9,10
Magnetitite 9
Marcasite
  Vug 10
Metamorphism 11
Mica
  see biotite-phlogopite

Nepheline
  Carbonate 11
Niobium 3,13

Petrology 11,14-20
Phlogopite
  Vugs 9,10
Prospecting
  Recommendations 13

Proterozoic 6-11
Pyrite
  Vugs 6,10
Pyrochlore
  Silicocarbonatite 19
  Sovite 14,16,17
  Sovite/silicocarbonatite 11
Pyrrhotite
  Sovite/silicocarbonatite 11
  Vugs 9,10

Quartz
  Vug 10

Radioactivity 13
Rare earths 3,6,9,13
Richterite 9
Rims
  see Zonation

Silicocarbonatite 3,6-11
  Analyses
    Average chemical compositions 37
    Major elements 23
    Normative minerals 35
    Trace elements 29
  Nomenclature 5
  Petrology 16,18,19

Sovite 3,6-11
  Analyses
    Average chemical compositions 36
    Major elements 21-23
    Normative minerals 30-35
    Trace elements 24-29
  Nomenclature 5
  Petrology 16-20
Synchysite 9

Vugs
  Carbonatite 6,9,12
  X-ray diffraction 10

X-ray diffraction of Vugs 10

Zircon
  Biotite-phlogopite 10
Zonation
  Amphibole 9
  Biotite-phlogopite 10,14,15, 16,17,18,19,20
    Metamorphism 11
  Carbonate 17,20
  Garnet 11
  Pyrochlore 11,14